

GreenUp Conference - Advancing toward a Safer and Sustainable Future

Bio-Based Materials for Sustainable Production and a Circular Economy

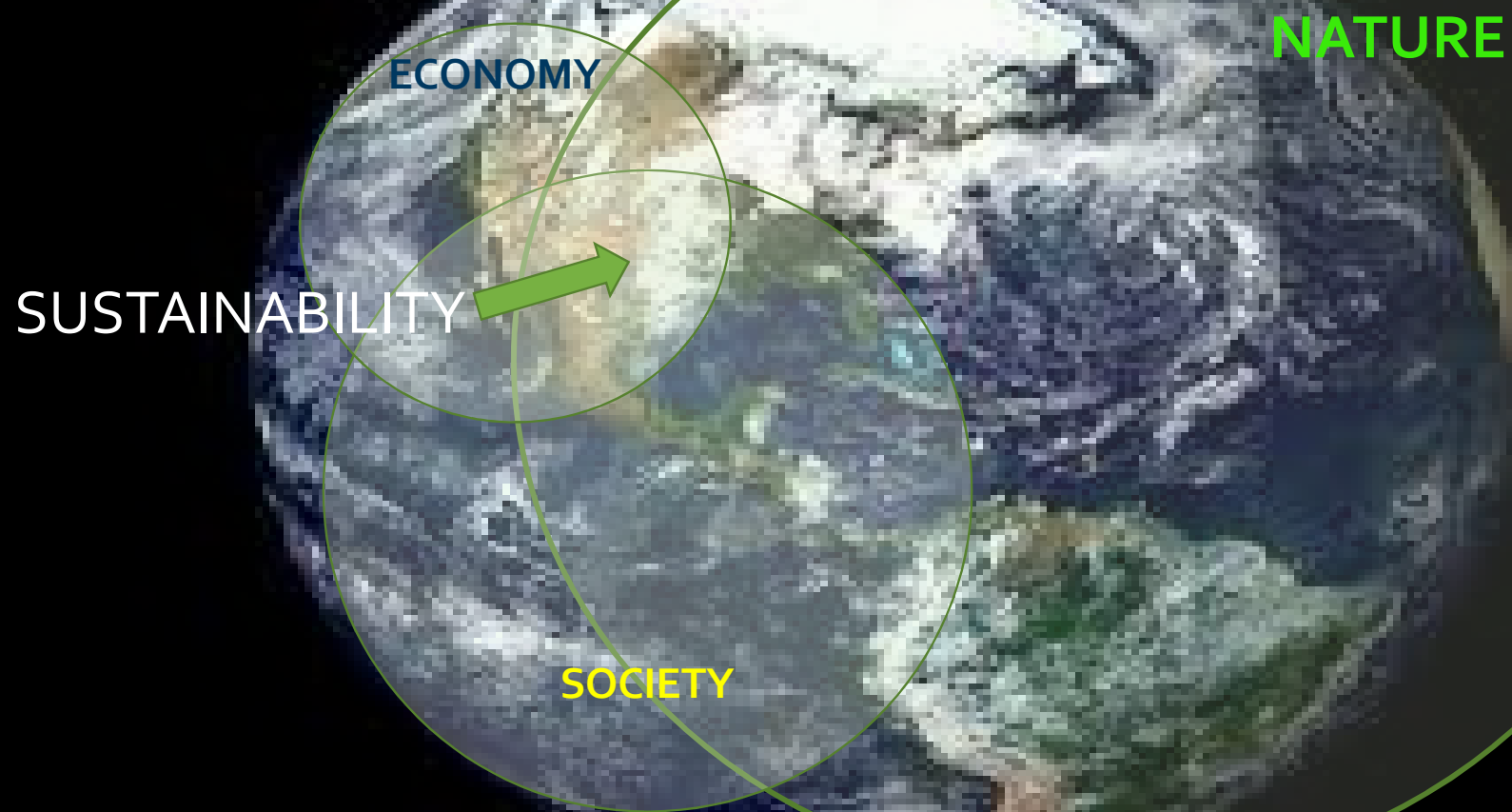
Ann Arbor, MI

November 4th, 2015

Presenter:

Silvia Leahu-Aluas, Principal, Sustainable Manufacturing Consulting





WHAT IS SUSTAINABLE MANUFACTURING

Sustainable manufacturing *is a business practice of the industrial sector, which expands all the company's processes and decisions into the social and natural environments it operates in and affects, with the explicit objective of having a neutral or positive impact, while pursuing the desired level of technological and economic performance.*

Sustainable Manufacturing Consulting

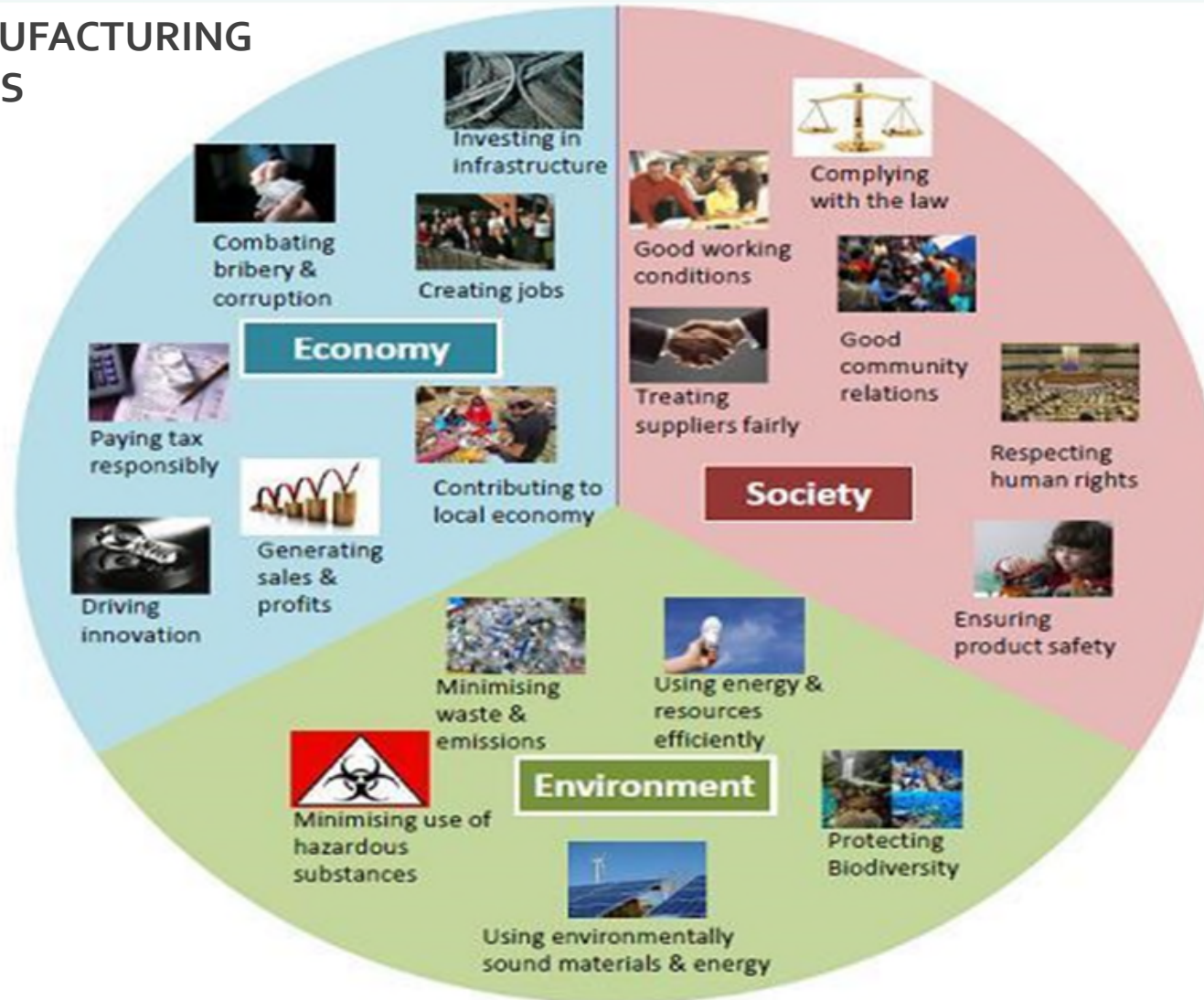
Sustainable production is the creation of goods and services using processes and systems that are:

- Non-polluting
- Conserving of energy and natural resources
- Economically viable
- Safe and healthful for workers, communities, and consumers
- Socially and creatively rewarding for all working people."

Lowell Center for Sustainable Production

<http://www.sustainableproduction.org/>

SUSTAINABLE MANUFACTURING ASPECTS



<http://www.oecd.org/innovation/green/toolkit/aboutsustainablemanufacturingandthetoolkit.htm>

WHAT IS THE CIRCULAR ECONOMY

“A circular economy is one that is restorative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles.”

Ellen MacArthur Foundation

<http://www.ellenmacarthurfoundation.org/>

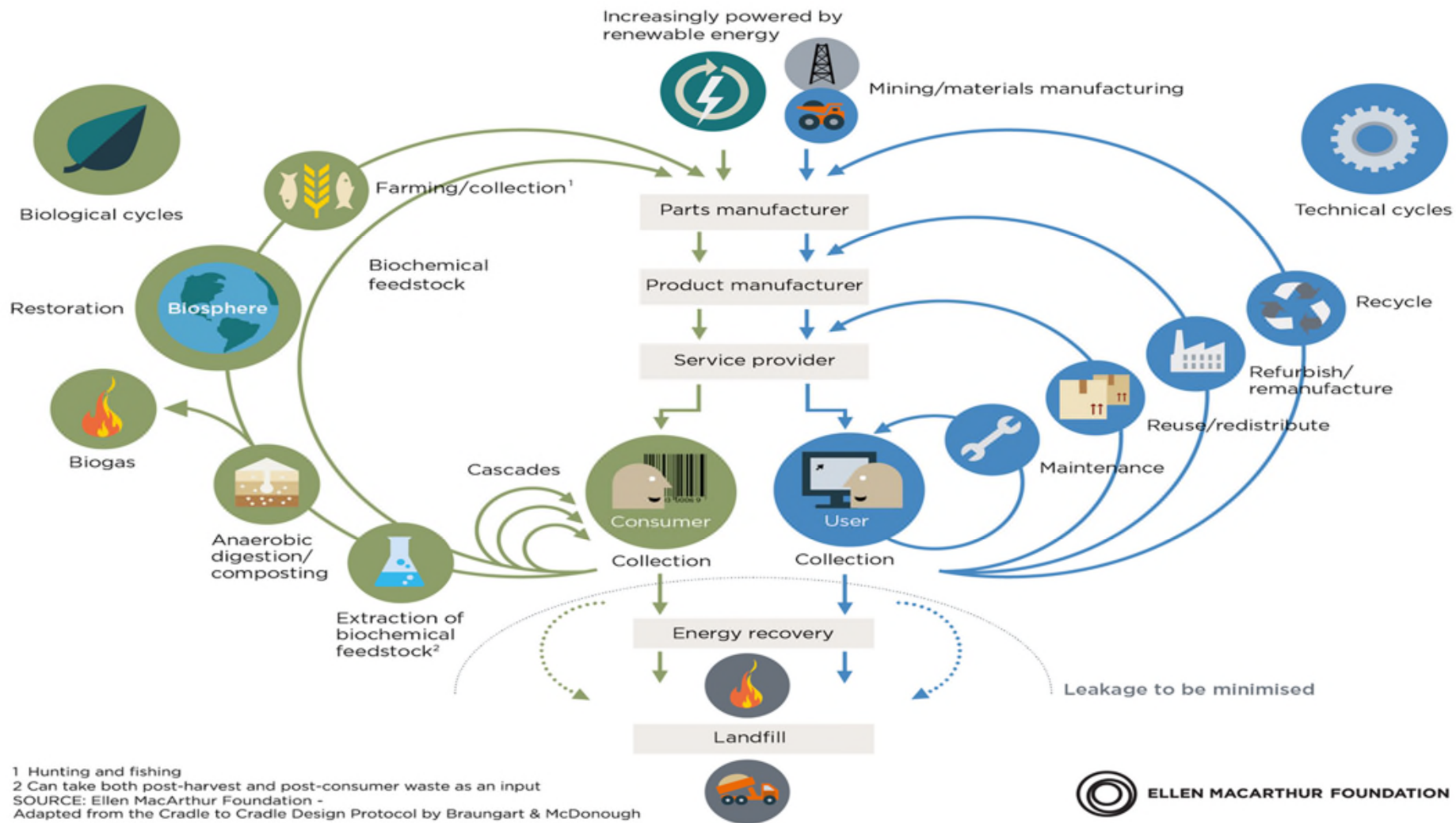
WHAT IS THE CIRCULAR ECONOMY

Industrial model designed and managed around **circular flows** of resources, products, processes that are

- Renewable, long-lasting, high value
- Low carbon, low entropy, low waste
- Non-toxic, clean, nourishing, healthy

Similar concepts: blue economy, industrial symbiosis, by-product synergy, steady-state economy, industrial ecology, eco-industrial parks, bio-based economy, farm-to-factory sustainable system

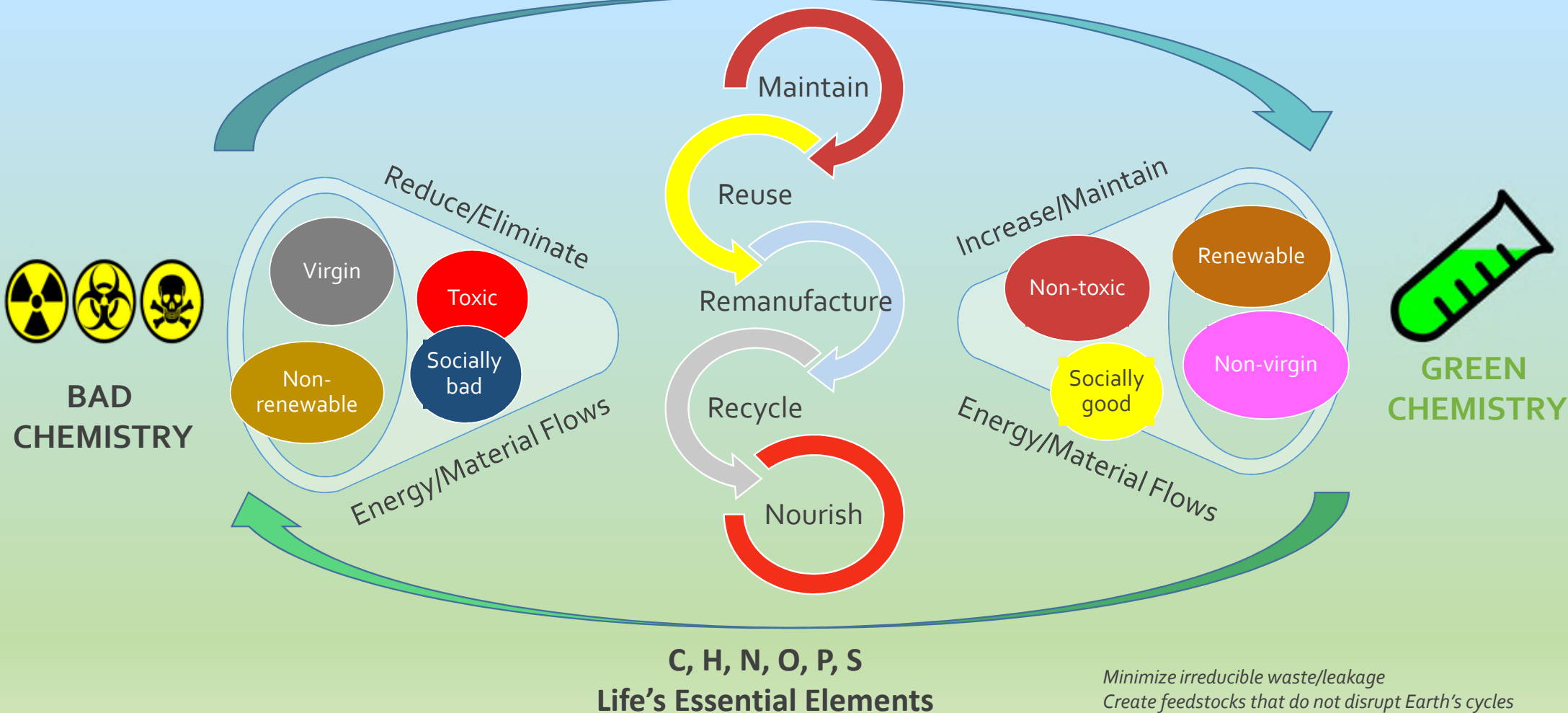
CIRCULAR ECONOMY - an industrial system that is restorative by design





Natural nuclear fusion power plant
Virtually free, infinite
Renewable

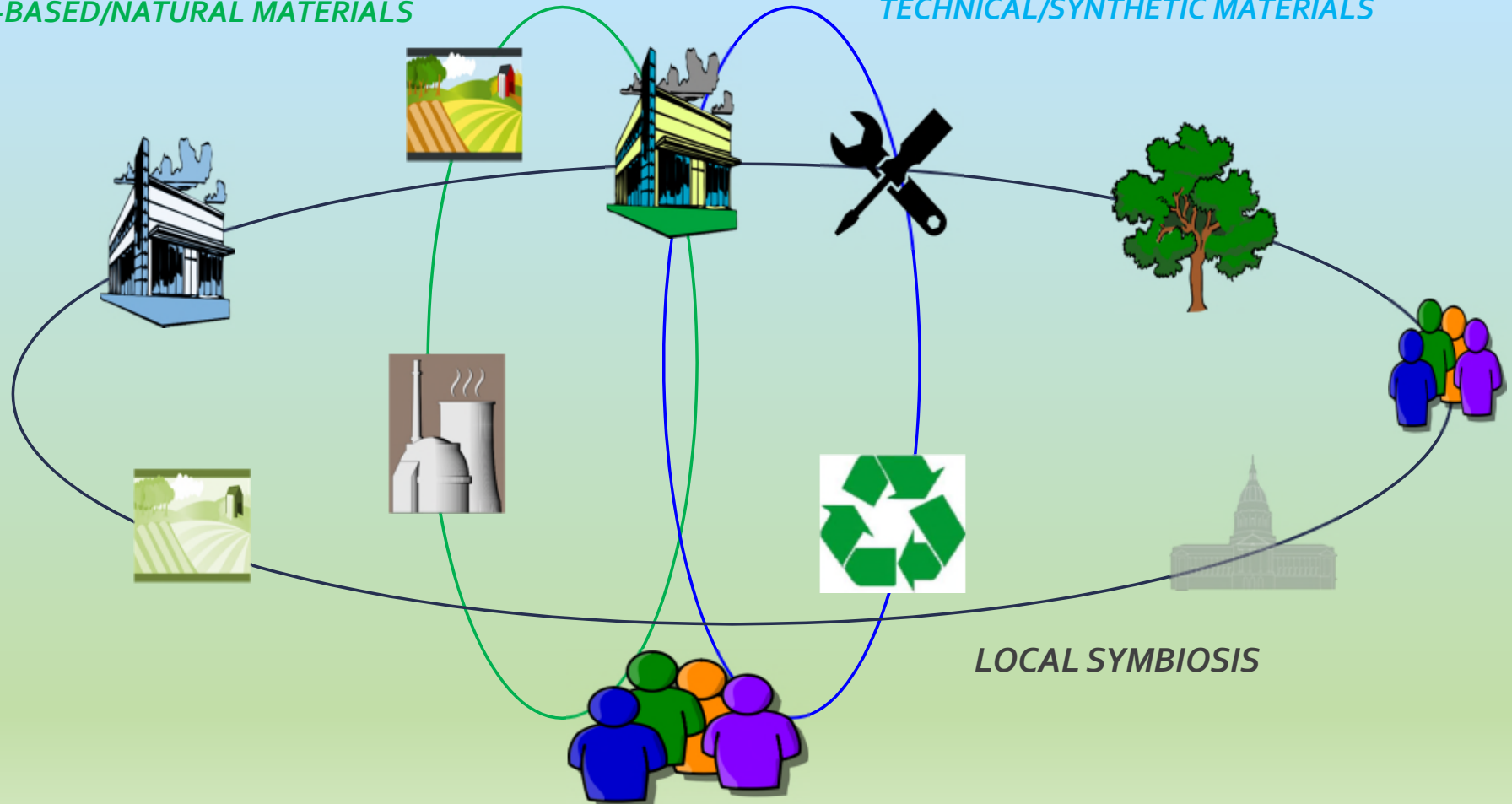
Earth's Biogeochemical and Hydrological Cycles



PRODUCT CIRCLES

BIO-BASED/NATURAL MATERIALS

TECHNICAL/SYNTHETIC MATERIALS



WHAT IS THE CIRCULAR ECONOMY

- Operates on two planes
 - Product circles with flows of natural and technical materials between producers, servicers and users
 - Growth and disposal are replaced by product circles of maintenance, long-lasting value and usage
 - Local symbiosis connects market and non-market stakeholders with the shared goal of prosperity and sustainability for all
- In both planes, waste not acceptable
 - For every waste flow, feedstock demand is searched or created

WHAT ARE BIO-BASED MATERIALS

“We define a “biomaterial” or a “biobased material” as any material made from current living organisms (as opposed to non-renewable fossil fuels that are made from prehistoric plants), including agricultural crops and residues, trees, and algae. “Sustainable biomaterials” are those that are (1) sourced from sustainably grown and harvested cropland or forests, (2) manufactured without hazardous inputs and impacts, (3) healthy and safe for the environment during use, and (4) designed to be reutilized at the end of their intended use such as via recycling or composting.”

[Sustainable Biomaterials Collaborative](#)

BIO-BASED MATERIALS FOR A MIDWESTERN CIRCULAR ECONOMY

- Industrial hemp
 - Cannabis Sativa
 - Grown in over 30 nations
 - From mandatory to abandoned as a US crop
 - Farming and industrial know-how is lost in the US
 - Growing the plant in USA requires DEA approval
 - 2014 US market for hemp based products estimated at \$620 mil
 - US farmers are kept out of this market

[Agricultural Marketing Resource Center](#)
[Hemp Industries Association](#)

BIO-BASED MATERIALS FOR A MIDWESTERN CIRCULAR ECONOMY

- Kenaf
 - Hibiscus Cannabinus
 - Grown primarily in Southeast Asia
 - Natural Fiber Composites \$3B Annual/10% AGR
 - US is the #1 Consumer of Natural Fibers
 - Versatile, multi-purpose use without regulatory constraints
 - No Inputs; Water, Herbicides, Pesticides, Fertilizer
 - Sequesters up to 20 tons of CO₂ per acre

BIO-BASED MATERIALS FOR A MIDWESTERN CIRCULAR ECONOMY

- Benefits
 - Rotational crops
 - Less polluting/water use crops
 - Alternative land use
 - Phytoremediation/phytomining
 - Displace fossil-based (bad chemistry) materials with plant-based (green chemistry) materials
 - Keep forests with all their beauty and carbon sequestration in place
 - Stability and prosperity for family farms and small businesses

BIO-BASED MATERIALS FOR A MIDWESTERN CIRCULAR ECONOMY

- Multi-purpose crops
 - Paper and Pulp
 - Automotive Components
 - Green Building Materials
 - Phytoremediation
 - Carbon Sequestration
 - Tensile Strength
 - Bio-Plastics
 - Textiles
 - Energy
 - Livestock Feed and Bedding

BIO-BASED MATERIALS FOR A MIDWESTERN CIRCULAR ECONOMY

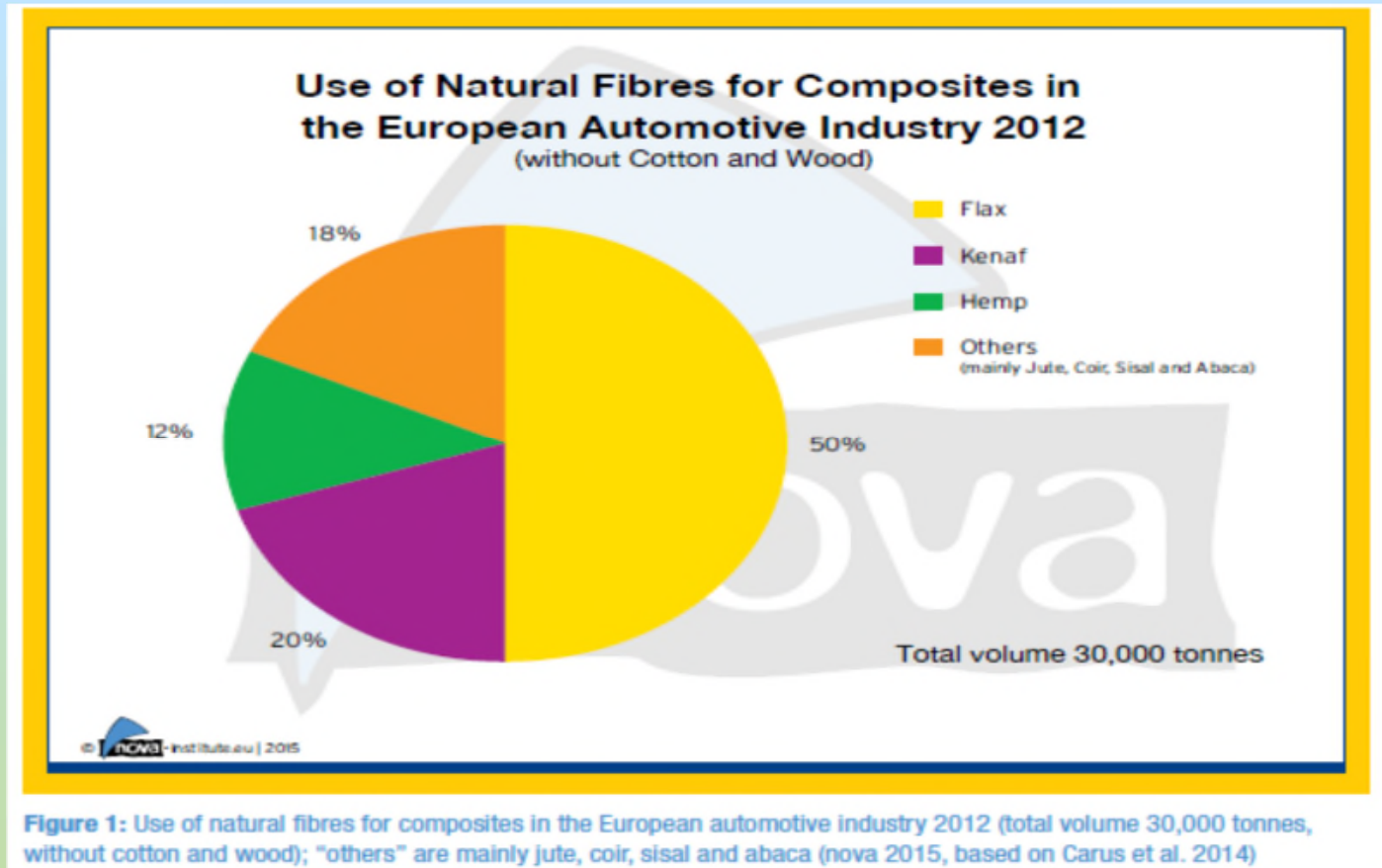


[Purdue University, Indiana Hemp Pilot Plots](#)



[EcoBridge Industries, Kentucky Kenaf Farm](#)

BIO-BASED MATERIALS FOR A MIDWESTERN CIRCULAR ECONOMY



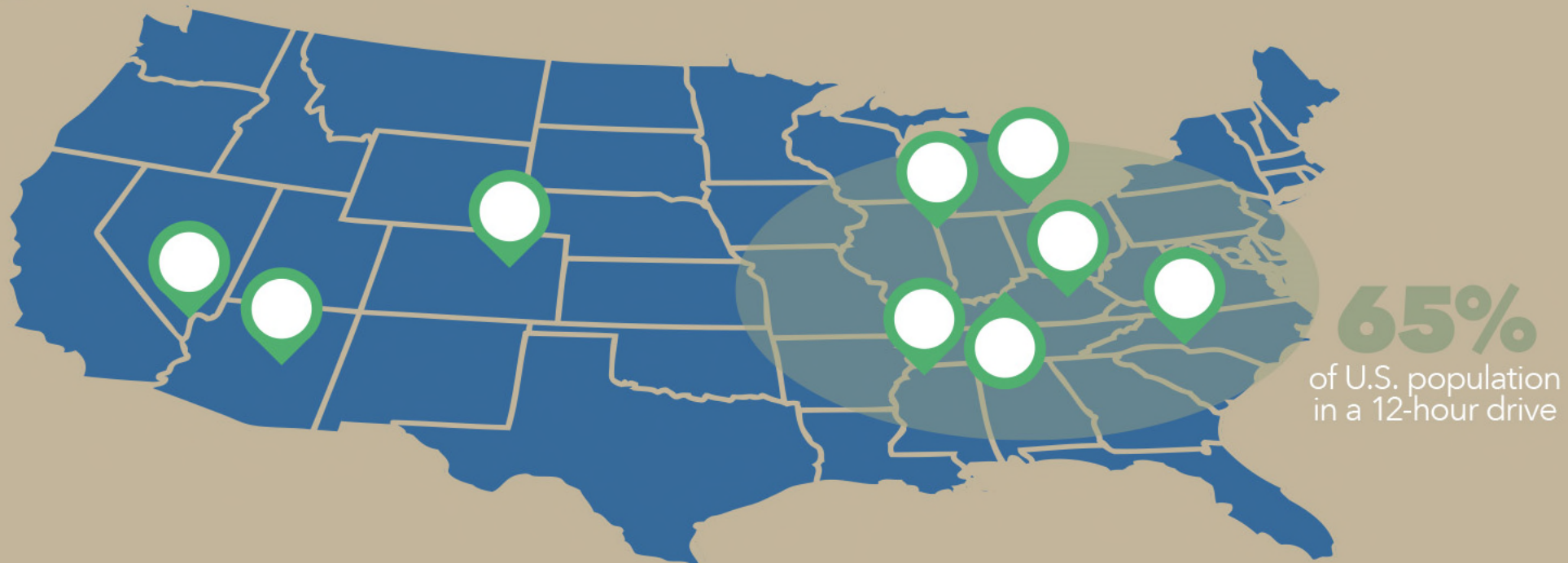
Carbon Footprint and Sustainability of Different Natural Fibers for Biocomposites and Insulation Material

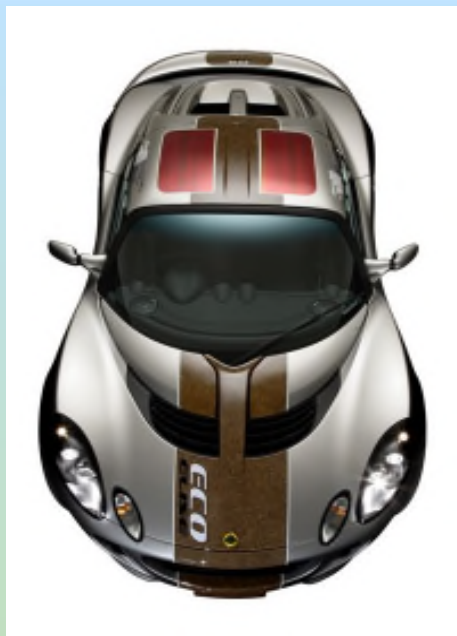


[Hempcrete Push House Asheville, North Carolina](#)



GOOD FOR JOBS





<http://www.lotuscars.com/engineering/eco-elise>



“The Eco Elise project promotes a different perspective on “green”, one which does not revolve solely around tailpipe CO₂. This holistic approach is in keeping with the progressive Lotus culture, driving Lotus to become the world’s green automotive consultancy. Sustainable materials, hemp, eco wool and sisal have been developed for body panels and trim and, combined with hi-tech water based paint solutions, showcase new affordable green technologies. The green credentials of the technology on show in the Eco Elise have been analysed throughout the lifecycle of the car.

[...] The renewable materials have been incorporated into the project, with hemp, eco wool and sisal providing natural, biodegradable engineering materials. Cleaner manufacturing processes have been sought, utilising the latest water based paint technology. Using this paint system saves energy and reduces emissions of solvents from the paint shop. Solar panels have been set into the hemp hard top to help power the electrical systems and give a means of renewable energy generation. With the use of locally farmed hemp, the carbon miles to produce the Eco Elise are reduced, in keeping with the holistic approach to this vehicle. “





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TO THIS



Commercial crop of kenaf planted in Kentucky; auto applications a potential target

By Stephen Moore

Published: October 21st, 2015

Share

EcoBridge Industries (Louisville, KY) has planted its first commercial crop of kenaf as a vehicle to maturing the markets for natural fibers grown in Kentucky, and the U.S. The company intends to fulfill the mission of "Growing America" by focusing on renewable and natural resources of fibers that can be used in a variety of industries, from paper products to green building materials. The current crop will be harvested in late October 2015.



Door trim base material incorporating kenaf reinforcement adopted on the Lexus GS.

A typical kenaf crop can be grown in about 150 days from seed to harvest. Depending on the use of the crop, specifications required for use and the type of harvest necessary, fiber yields range from 6 to

10 tons per acre annually. A diverse range of new kenaf products suggests a bright future for the continued expansion of kenaf as a commercial crop in Kentucky.

"We are growing kenaf as foundation for proving the many paths forward for Kentucky's agricultural resources in various industries. We are now seeking partnerships with processors and manufacturers in the areas of green building applications, paper production, and bioplastics," said Sean M.



Related Articles

- Ten years on: Biomaterials use surges at Toyota
- Japan's NEC Develops Reinforced Pile Polymer
- Toyota promotes Ecological Plastics in interiors
- Bio-based auto plastics conference to debut

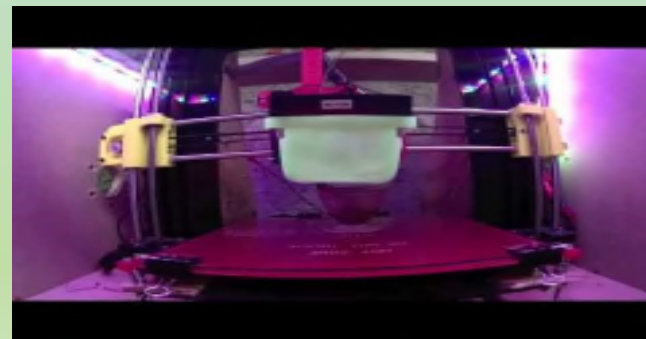


3D printing – a manufacturing process with great potential for customization, made-to-order, decentralized, collaborative, open-source, material waste reduction

Matterlab, New-York <http://matterlab.xyz/materials/>

Start-up, Italy “Kanèsis is not a product, but it is the name of an ambitious project that puts the most receptive and creative Sicilian minds together,” says Caruso. “Our purpose is to give a future to our land not based on oil/petrol. We can develop all the products we need from the fields, and this is our aim. Developing bio-fuels, paper, bio-bricks, bio-composites from earth, thus generating thousands of jobs in a country where 70% of the land is currently abandoned: this will be the crux of our crowdfunding campaign!”

<http://kanesis.eu/>



Thank you,

Silvia Leahu-Aluas

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Q & A

WHAT IS SUSTAINABILITY

- Economy depends on society and both depend on nature
- Nature exists without us, humans, vice versa is not possible
- Nature includes Earth, but Earth is the only planet we know of that can sustain life and human civilization
- There is a constant exchange of resources and constraints between the 3 dimensions: economic, social and natural
- Sustainability allows us to perform optimally on all 3
- Everything we do cannot use more than our planet's resources
- We share the planet with many living and nonliving things

WHAT IS SUSTAINABILITY

Sustainable development

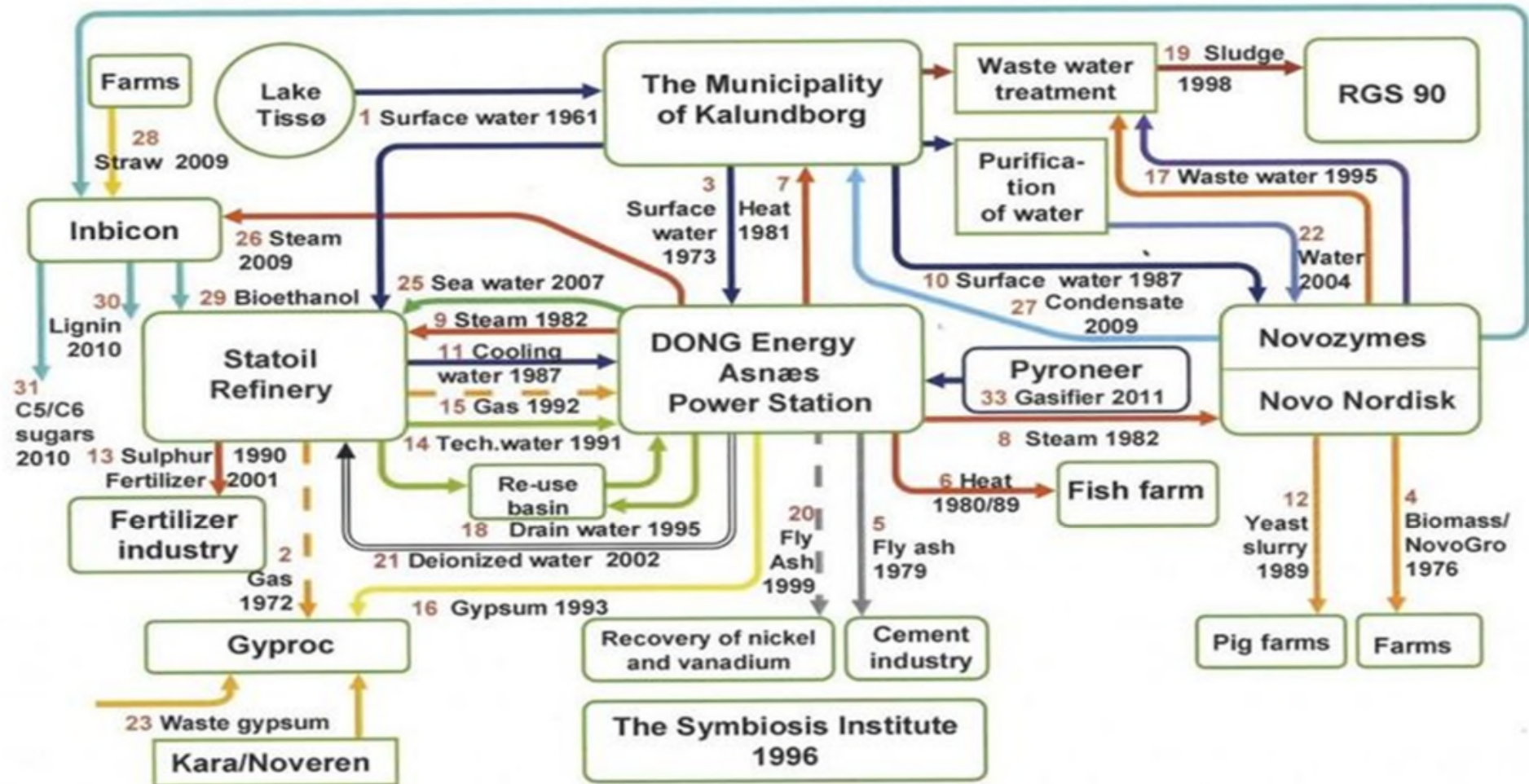
"...is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- *the concept of **needs**, in particular the essential needs of the world's poor, to which overriding priority should be given; and*
- *the idea of **limitations** imposed by the state of technology and social organization on the environment's ability to meet present and future needs."*

***United Nations Conference on Environment and Development (UNCED)
1992 Rio de Janeiro, Brazil***

WHAT IS SUSTAINABLE MANUFACTURING

- Sustainable manufacturing is part of the larger concept of sustainable development
- It is a model for how to make things within the global framework for sustainable development
- Sustainable manufacturing performance includes critical aspects on all its three dimensions
- Ideally, we should give them equal weight and accomplish all
- Ideally, we should have only a positive impact on all three dimensions and their aspects



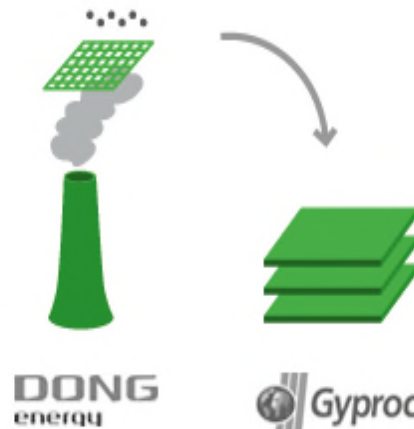
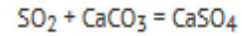
Waste stream example

Organic waste from Novozymes is made into agricultural fertilizer.



Waste stream example

Smoke from DONG is made into gypsum at Gyproc.



Result examples

- Yearly CO₂ emission reduced by 240.000 tons.
- 3 million m³ of water saved through recycling and reuse.
- 30.000 tons of straw converted to 5,4 million litres of ethanol.
- 150.000 tons of yeast replaces 70% of soy protein in traditional feed mix for more than 800.000 pigs.
- Recycling of 150.000 tons of gypsum from desulphurization of flue gas (SO₂) replaces import of natural gypsum (CaSO₄).

<http://www.symbiosis.dk/en>



Lions Mane Mushroom grown on hemp 2015

Purdue University 2015 Industrial Hemp Pilot



Super SSR Modular Block Wall System



Residential Wall System

Super SSR Block is the ideal construction material for the environmentally conscious architect and homebuilder. High insulation qualities and a negative carbon material classification go together with low building maintenance and extended material lifetime to create the ultimate structure.

Details of performance:

- High insulation value = R27 to R40 or $\lambda=0.07\text{W/m.K}$
- Fire resistance > **1 hour fire rating**
- Mean acoustic absorption coefficient = **0.7 NRC**
- Atmospheric CO₂ Removal > **1 Tonne per house**
- Vertical load bearing compression strength > **40 MPa 36,000 lbs. per foot (26-33 N/mm²)**
- Standard SSR11 block size is **8" h x , 21" w x 11" d (200mm x 540mm x 280mm)**
- Density of **330 kg/m³ or 11 kg (22 lbs) per block**
- Non-toxic building material with high heat capacity = **1600 J/Kg**
- No mould, due to **23 gm/m²/mm hg vapour and 0.7 gm/m²/mm hg air permeability**

Green, environmentally-friendly, sustainable and renewable building blocks



stacking and interlocking design



interior finish with Venetian plaster and paint

Features & Benefits



Longevity

Low maintenance and long lasting



Safety

Safe healthy natural materials



Comfort

Regulates temperature in winter and summer



Strong

High load bearing capacity



Sustainable

Bio fiber captures CO₂



Economical

Costs the same or less than comparable construction materials



Fast Construction

Rapid assembly system



Fire Resistant

over 1 hour fire rating



JustBioFiber, a building product that replaces the existing building system: it's the brick, the insulation and the siding all rolled into one block. *Jim Poyser-Nuvo Magazine*



Organic farming - no herbicides, pesticides, fungicides

Phytoremediation (heavy metals)

Low nutrient requirement

Whole plant usage

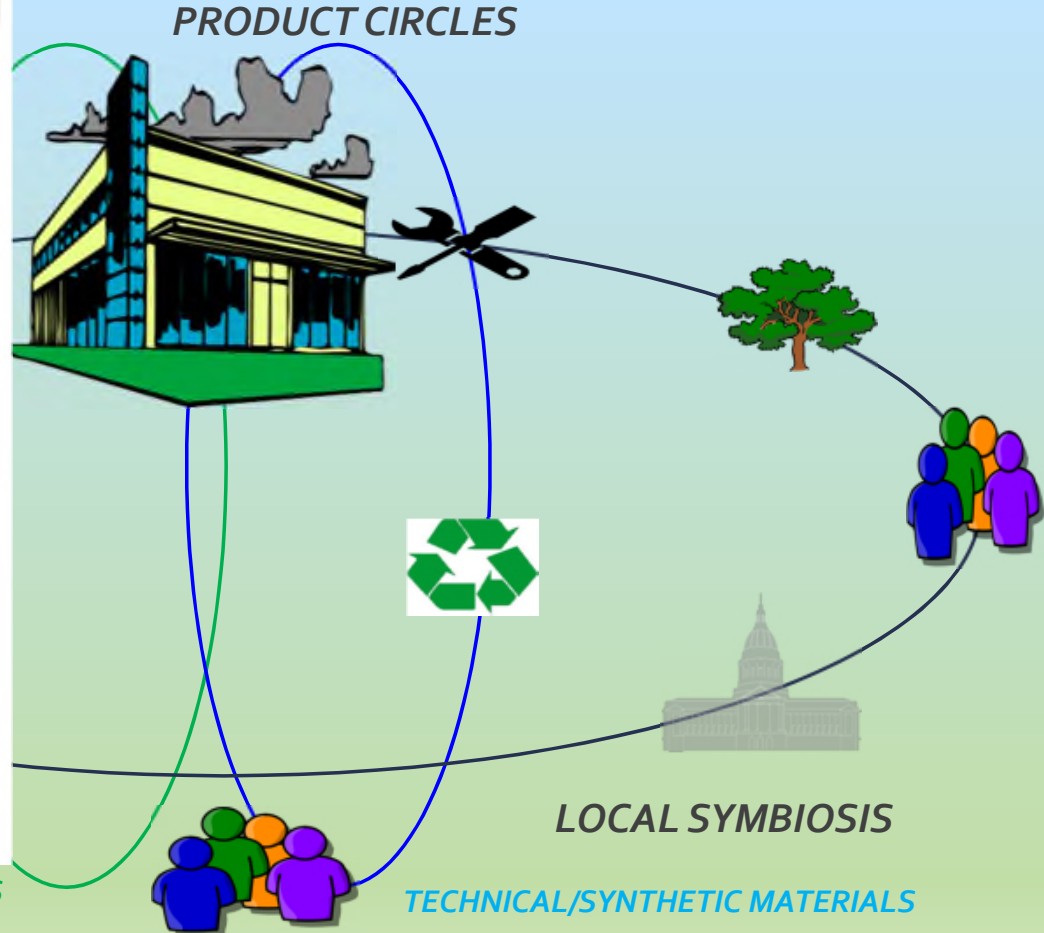
Multiple, diverse markets

Urban farming





BIO-BASED/NATURAL MATERIALS



<http://www.theihrfoundation.com/>

PEOPLE

Producers and users instead of consumers

Dream jobs for all

Prosperity and happy life for all

Meaningful work at every skill level

Non-tradable jobs

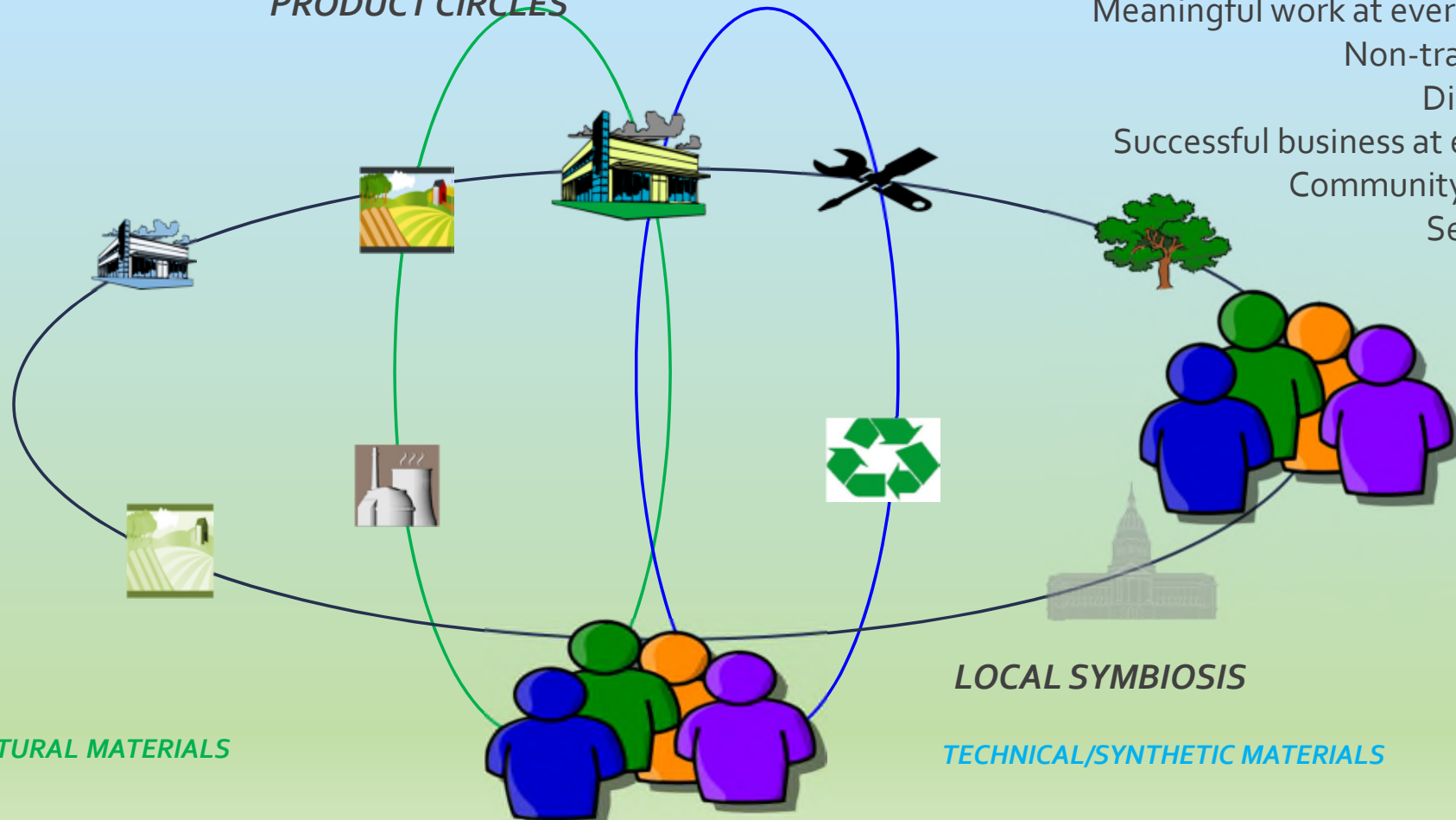
Diverse skills

Successful business at every scale

Community resilience

Self-reliance

PRODUCT CIRCLES



BIO-BASED/NATURAL MATERIALS

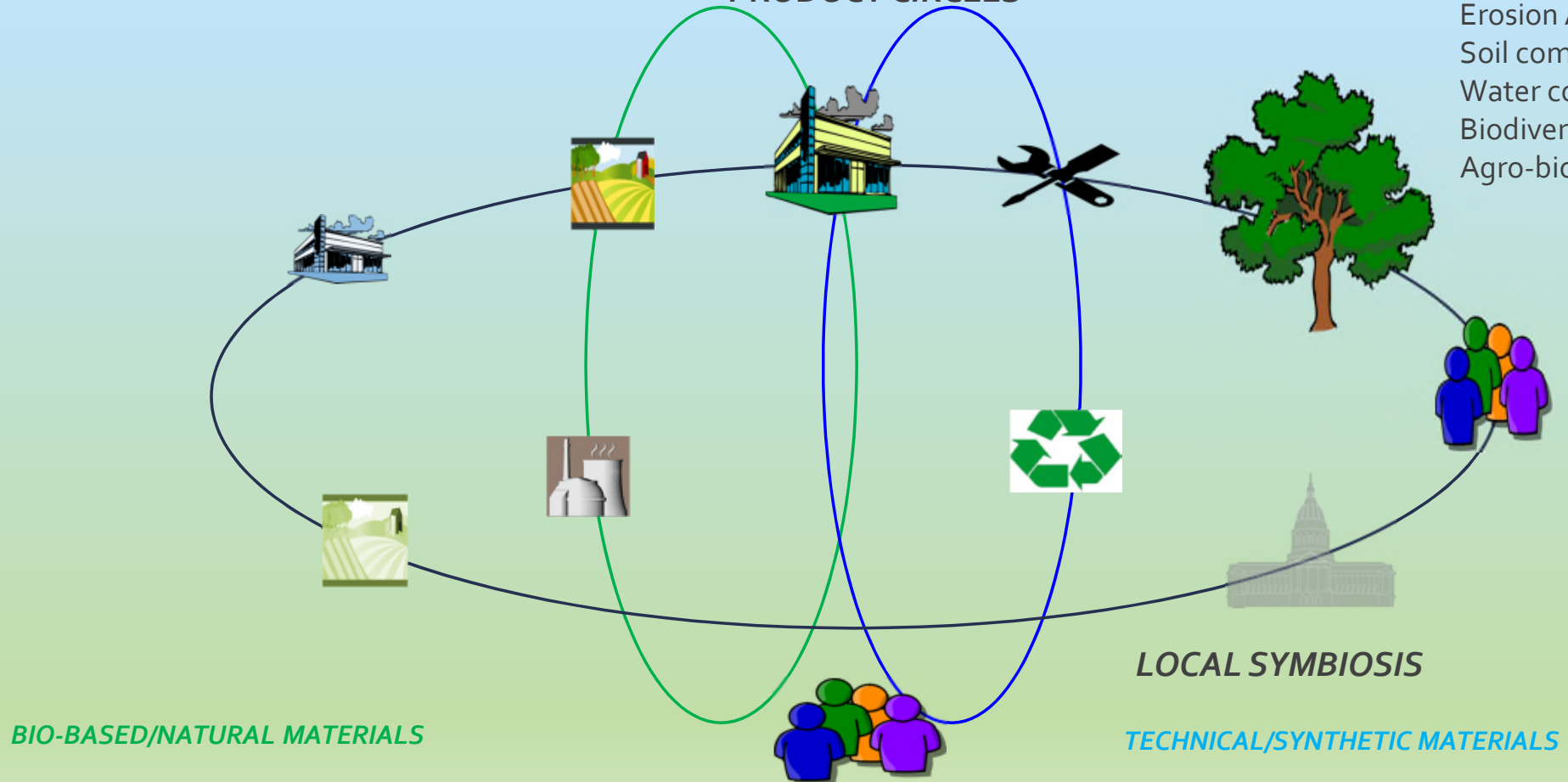
LOCAL SYMBIOSIS

TECHNICAL/SYNTHETIC MATERIALS

Environmental impact of cultivation [European Industrial Hemp Association](#)

Nutrient depletion A
Pesticides A
Erosion A/B
Soil compaction A
Water consumption B
Biodiversity B
Agro-biodiversity A

PRODUCT CIRCLES



“As hemp makes a comeback in the U.S. after a decades-long ban on its cultivation, scientists are reporting that fibers from the plant can pack as much energy and power as graphene, long-touted as the model material for supercapacitors.

His [Dr. David Mitlin] team found that if they heated the fibers for 24 hours at a little over 350 degrees Fahrenheit, and then blasted the resulting material with more intense heat, it would exfoliate into carbon nanosheets.

Mitlin’s team built their supercapacitors using the hemp-derived carbons as electrodes and an ionic liquid as the electrolyte. Fully assembled, the devices performed far better than commercial supercapacitors in both energy density and the range of temperatures over which they can work. The hemp-based devices yielded energy densities as high as 12 Watt-hours per kilogram, two to three times higher than commercial counterparts. They also operate over an impressive temperature range, from freezing to more than 200 degrees Fahrenheit.”

[ACS could-hemp-nanosheets-topple-graphene-for-making-the-ideal-supercapacitor](#)

<http://www.mitlingroup.com/reas.php>

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<http://corporate-citizenship.com/our-insights/ahead-curve-circular-economy/>

Full-service C2C Working Environment in The Netherlands

<http://www.park2020.com/>

The Great Recovery - Redesigning the Future Project

<http://www.greatrecovery.org.uk/>

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<http://www.asknature.org/>

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<https://www.globalreporting.org/Pages/default.aspx>

Sustainability Accounting Standards Board

<http://www.sasb.org/>

ASTM International Proposed Standard for Sustainable Manufacturing

<http://www.astm.org/COMMIT/SUBCOMMIT/E6013.htm>

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<http://industries.ul.com/environment>

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<http://warr.org/>

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<http://www.icleiusa.org/>

Future-Fit Business Benchmark

<http://futurefitbusiness.org/>

Institute of Making

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